Bluestone ENVIRONMENTAL GROUP
301 Lindenwood Drive | Suite 102 | Malvern, PA 19355
610.647.9500 | www.bluestoneenviro.com

Residential Human Health Risk Evaluation – Olin OU1/OU2 Soils
Olin Chemical Superfund Site
Wilmington, Massachusetts

To:	J. DiLorenzo, EPA
Copy To:	J. Brunelle, J. Lambert
From:	C. Woods
Subject:	Residential Human Health Risk Evaluation – Olin OU1/OU2 Soils
Date:	1/17/2020

1.0 Introduction

Potential risks from human exposures to soils at the Olin Chemical Superfund Site Operable Unit 1 & Operable Unit 2 (Olin OU1/OU2) exposure areas were evaluated in the 2015 Final Remedial Investigation Report – Operable Unit 1 & Operable Unit 2 (AMEC, 2015). Potential future residential risks were not included. This memorandum has been prepared by Bluestone Environmental Group to provide the U.S. Environmental Protection Agency (EPA) with an understanding of what human health risks may be if the site is used for residential use in the future. The following receptors were evaluated under a reasonable maximum exposure (RME) scenario:

- Future residents exposed to surface soils collected from 0-1 foot below ground surface (bgs) and
- Future residents exposed to subsurface soils collected from 1-10 feet bgs.

The primary routes of exposure evaluated include incidental ingestion and dermal contact with soil aw well as, inhalation of fugitive dust and inhalation of volatile emissions from soils.

Exposure assumptions and risk results associated with RME scenarios for future residents are those used in the development of EPA Regional Screening Levels (RSLs) for residents.

Cancer risk results are compared to EPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$. Total non-cancer hazard indices (HIs) are compared to 1. For lead, EPA Region I's risk reduction goal is to limit the probability of a child's blood lead concentration exceeding 5 micrograms per deciliter (µg/dL) to 5 percent or less. Current lead models predict that where the average lead in soil concentration is 200 milligrams per kilogram (mg/kg) or less, blood lead levels will meet EPA's risk goal.

This memorandum presents estimated potential risks from future residential exposures to soils at the Olin Chemical Superfund Site using a simplified ratio approach. This approach follows the

example of the RSL calculator (EPA, 2019) and incorporates the latest toxicity values, accepted exposure assumptions, and risk methodologies.

2.0 Selection of Representative Samples

Samples used in this screening level risk assessment to evaluate potential exposures to potential future residents included surface soils collected from depths of 0 to 1 foot and subsurface soils collected from depths of 1 to 10 feet at the OU1/OU2 potential exposure areas as summarized in AMEC, 2015 Appendix M Baseline Human Health Risk Assessment (OU1/OU2 HHRA) on Tables 2.3.1 and 2.3.2. Tables 1 and 2 of this memorandum present the statistical summaries of the data for detected contaminants in the surface soil and subsurface soil datasets from those OU1/OU2 HHRA tables, respectively.

3.0 Selection of Contaminants of Potential Concern (COPCs)

The selection of Contaminants of Potential Concern (COPCs) is a risk-based screening step to identify chemicals that should be included in the quantitative risk estimates. The selection of COPCs was based on chemical substances found at the Site including chemical-specific concentrations, occurrence, distribution, and toxicity. COPCs include only those chemicals with positive detections, and are limited to those chemicals that exceed the selection criterion. A chemical was selected as a COPC if the maximum detected concentration was greater than the associated risk-based concentration (RBC). No potential COPCs were eliminated based on low frequency of detection.

The screening criteria used to identify COPCs are presented in Tables 1 and 2 and include the following:

- **EPA Regional Screening Levels (RSLs) for Soil Exposures.** The maximum concentrations detected in surface soils and subsurface soils were compared to EPA RSLs for residential soil (EPA, 2019) as described below. The EPA RSL Table identifies concentrations of potential concern in various media (air, drinking water, and soil) using certain reasonable maximum exposure default assumptions.

  The EPA RSL residential soil exposure values were developed by EPA based on the methodology presented in *RAGS HHEM, Part B* (EPA, 1991) and consider the ingestion, dermal, and inhalation exposure routes. The EPA RSL residential soil exposure values for carcinogens were developed by EPA using an age-adjusted exposure equation, which assumes that a receptor is exposed to soil at a frequency of 350 days per year for a 26-year exposure period (6 years as a child and 20 years as an adult). The EPA RSLs for chemicals with non-cancer effects are based on a child exposed to soil at a frequency of 350 days per year for a 6-year exposure period. For carcinogenic chemicals, the values used for COPC screening are based on a $1x10^{-6}$ target incremental lifetime cancer risk. EPA RSLs for chemicals with non-cancer effects are developed for target hazard quotient (HQ) of 1.0 and

for a target HQ of 0.1. The RSLs for a target HQ of 0.1 were used to select COPCs to avoid omitting chemicals that may contribute to a total hazard index (HI) of greater than 1.0. For contaminants with both carcinogenic effects and non-cancer effects, the lower of the RSL based on non-cancer HQ of 0.1 and the RSL based on $1x10^{-6}$ cancer risk, was used for COPC screening.

- **EPA Soil Lead Guidance.** EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model, predicts that where the average lead in soil concentration is 200 mg/Kg or less, blood lead levels will meet EPA's risk goal (EPA Region I, 2018). Maximum soil concentrations are compared to this target soil concentration.

- **Massachusetts Department of Environmental Protection (MADEP) Massachusetts Contingency Plan (MCP) S-1 Standards.** Petroleum hydrocarbon fractions were included in the COPC selection process through comparison to MADEP MCP S-1 standards for residential soils (MADEP, 2014).

Tables 1 and 2 also indicate which contaminants were selected as COPCs based on comparison of maximum detected concentrations to the screening criteria discussed above.

Chemical-Specific Considerations in COPC selection

COPC selection for trimethyl pentenes (TMPs) was evaluated through use of screening levels developed by Olin and presented in the OU1/OU2 HHRA Attachment 6.

COPC selection for total chromium was performed through use of trivalent chromium screening levels for COPC selection, because of the availability of separate hexavalent chromium data. Based on this comparison, total chromium was selected as a COPC in surface soil only.

Surrogate screening levels were used for other detected analytes as detailed in the notes on Tables 1 and 2.

4.0 Exposure Point Concentrations (EPCs)

For purposes of this screening level risk assessment, maximum detected concentrations as reported in the OU1/OU2 HHRA Tables 2.3.1 and 2.3.2 were used as exposure point concentrations (EPCs).

5.0 Exposure Scenario and Assumptions

Potential receptors include future residential exposures.

For future residents, non-cancer risks are based on young children ages 0 to 6 years exposed at a frequency of 350 days per year for a 6-year exposure period. Cancer risks are based on future residents exposed to soil at a frequency of 350 days per year for a 26-year exposure period (6 years

as a child and 20 years as an adult). Residents are assumed to ingest an average of 200 mg/day for six years for the child and 100 mg/day for 20 years for the adult. Hands, forearms, lower legs, and head are expected to be available for dermal contact for adults. For children, hands, forearms, lower legs, feet, and head are expected to be available for dermal contact. These exposure assumptions are built into the generic residential soil RSLs developed by EPA (EPA, 2019) for ingestion, dermal contact, and inhalation of dust pathways, along with default ingestion rates, dermal contact rates, inhalation rates, body weights, etc.

6.0 Risk Characterization

The hazards associated with non-cancer effects of COPCs are evaluated by dividing the soils EPCs by the non-cancer based RSLs based on a HQ of 1. The ratio of the soil EPC to the non-cancer based RSL is equal to the HQ. The total HI is generated by summing the individual HQs for all COPCs.

The risks associated with cancer effects of COPCs are evaluated by dividing the soil EPC by the EPA's cancer based RSLs and multiplying by $1x10^{-6}$. Total cancer risk is generated by summing the individual cancer risks for all COPCs.

Some contaminants have both carcinogenic effects and non-carcinogenic effects and therefore have both a cancer risk calculation and a HQ calculation.

Table 3 presents the estimated hazards and risks from potential future residential exposure to surface soils using this simplified ratio approach. Table 4 presents the estimated hazards and risks from potential future residential exposure to 1 to 10 foot soils using this simplified ratio approach. Results of the simplified ratio approach evaluation of hazards and risks from potential soil exposures to soils at the Olin Chemical Superfund Site OU1 and OU2 are discussed below.

Non-Carcinogenic Health Hazards

The total HIs developed for future child residents are as follows:

Receptor	HI
Child Resident exposed to surface soil	31
Child Resident exposed to subsurface soil	203

HIs below 1.0 indicate potential adverse non-cancer effects are not expected. HIs above 1.0 indicate potential adverse non-cancer effects are possible.

The total HIs for future child resident exposed to surface soils or subsurface soil are greater than EPA's target non-cancer risk level of 1.0. As detailed in Table 3, the greatest contributors to the total HI with individual contaminant HQ greater than 1.0 in surface soil in order of greatest to

lowest HQs were thallium, hexavalent chromium, silver, antimony, cobalt, iron, arsenic, and benzo(a)pyrene. As detailed in Table 4, the greatest contributors to the total HI with individual contaminant HQ greater than 1.0 in subsurface soil in order of greatest to lowest HQs were TMPs, bis(2-ethylhexyl)phthalate (BEHP), antimony, and benzo(a)pyrene.

Carcinogenic Risks

Cancer Risks developed for lifetime future residents are as follows:

Receptor (Timeframe)	Cancer Risk
Age-Adjusted Lifetime Resident exposed to surface soils	$4.1x10^{-3}$
Age-Adjusted Lifetime Resident exposed to subsurface soils	$7.0x10^{-4}$

The cancer risk estimates for lifetime residents exposed to surface soils or subsurface soil exceed the EPA targeted cancer risk range (10^{-4} to 10^{-6}). As detailed in Table 3, the greatest contributors to cancer risk for lifetime residents exposed to surface soils are hexavalent chromium and benzo(a)pyrene. The individual cancer risk estimates for these contaminants are greater than $1x10^{-4}$. The individual cancer risk estimates in descending order for arsenic, Aroclor 1260, several other PAHs, BEHP, hydrazine, and N-nitrosodi-n-propylamine are greater than $1x10^{-6}$. As detailed in Table 4, the greatest contributors to cancer risk for lifetime residents exposed to subsurface soils are BEHP and benzo(a)pyrene. The individual cancer risk estimates for these contaminants are greater than $1x10^{-4}$. The individual cancer risk estimates in descending order for hexavalent chromium, hydrazine, Aroclor 1260, N-nitrosodiphenylamine, arsenic, several PAHs, and ethylbenzene are greater than $1x10^{-6}$.

Lead Evaluation

Lead was identified as a COPC in surface soil; however, risks from lead exposure are not evaluated using the same methodology as other contaminants. Typically, the IEUBK Model for lead is used to assess residential exposures to lead. This model estimates blood lead concentrations. Studies indicate that infants and young children are most susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in children with elevated blood lead levels. Evaluation of the young child in a residential scenario is considered protective of adults, including pregnant women, and children in a less frequent exposure scenario, including recreational visitors. The EPA Region I risk reduction goal for contaminated sites is to limit the probability of a child's blood lead concentration exceeding 5 µg/dL to 5 percent or less (EPA Region I, 2018). As noted in Section 3.0, the IEUBK model predicts that where the average lead in soil concentration is 200 mg/kg or less, blood lead levels will meet EPA Region I's risk goal. The maximum lead concentration in surface soils was 210 mg/kg. The average concentration is less than the screening level. Therefore, lead is not a concern at this Site.

7.0 Uncertainty Discussion

There are uncertainties and variability associated with all HHRAs. This section summarizes these uncertainties and provides a qualitative assessment of whether the uncertainties may over or underestimate risks.

Risks from contaminants without RSLs were not estimated. This likely results in an underestimate of risk; however, these contaminants do not have accepted toxicity values and therefore, estimation of quantitative risks is not appropriate.

Soil background concentrations were not considered in this evaluation. Therefore, risks resulting from contaminants present below background levels may be reflective of background conditions and not site-related. A common example of this, which may apply to this site, is the presence of naturally occurring arsenic.

REFERENCES

AMEC, 2015. Final Remedial Investigation Report – Operable Unit 1 & Operable Unit 2. July.

Massachusetts Department of Environmental Protection (MADEP), 2014. Massachusetts Contingency Plan. April 2014

United States Environmental Protection Agency (EPA), 1991, Risk Assessment Guidance for Superfund – Volume I: Human Health Evaluation Manual (Part B) Interim Guidance Office of Emergency and Remedial Response Publication 9285.7-01B. December 1991.

United States Environmental Protection Agency Region I (EPA Region I), 2018. Lead in Soils. Office of Site Remediation and Restoration (OSRR) EPA Region I, January 2018.

United States Environmental Protection Agency (EPA), 2019. EPA's Regional Screening Levels Tables and Calculator for Chemical Contaminants at Superfund Sites, November 2019. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, November 2019.

Table 1
Data Summary and Selection of Chemicals of Potential Concern
Surface Soil (0-1 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)	Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection
	Volatile Organics													
71-55-6	1,1,1-Trichloroethane	0.003	J	0.071		MG/KG	A9CW-3	8 / 193	0.0022 - 1	0.071	ND	810 n	No	BSL
75-34-3	1,1-Dichloroethane	0.001	J	0.001	J	MG/KG	LAKE POLY-3	1 / 193	0.0022 - 1	0.001	ND	3.6 c	No	BSL
120-82-1	1,2,4-Trichlorobenzene	0.098		0.098		MG/KG	DB-C1	1 / 165	0.0022 - 1	0.098	ND	5.8 n	No	BSL
95-63-6	1,2,4-Trimethylbenzene	0.025		0.21		MG/KG	DB-C1	2 / 165	0.0022 - 1	0.21	ND	30 n	No	BSL
95-50-1	1,2-Dichlorobenzene	0.073	J	0.073	J	MG/KG	SB-420	1 / 165	0.0022 - 1	0.073	ND	180 n	No	BSL
107-06-2	1,2-Dichloroethane	0.001	J	0.001	J	MG/KG	LAKE POLY-3	1 / 193	0.0022 - 1	0.001	ND	0.46 c	No	BSL
108-67-8	1,3,5-Trimethylbenzene	0.13		0.13		MG/KG	DB-C1	1 / 165	0.0022 - 1	0.13	ND	27.0 n	No	BSL
107-39-1	2,4,4-Trimethyl-1-pentene	0.002	J	2.1		MG/KG	SB-420	10 / 192	0.0044 - 0.79	2.1	ND	0.8 n	Yes	ASL
107-40-4	2,4,4-Trimethyl-2-pentene	0.0056	J	0.61		MG/KG	SB-421	8 / 193	0.0044 - 0.79	0.61	ND	0.8 n	No	BSL
78-93-3	2-Butanone	0.004	J	0.004	J	MG/KG	LAKE POLY-3	1 / 193	0.011 - 20	0.004	ND	2700 n	No	BSL
75-07-0	Acetaldehyde	0.032	J	0.2	J	MG/KG	SB-435	17 / 60	0.2 - 1.1	0.2	ND	8.2 n	No	BSL
79-20-9	Acetic acid, methyl ester	7.2	J	7.2	J	MG/KG	SB-432	1 / 127	0.044 - 2.9	7.2	ND	7800 n	No	BSL
67-64-1	Acetone	0.011	JB	0.081	J	MG/KG	SS-461	13 / 193	0.006 - 20	0.081	0.037	6100 n	No	BSL
71-43-2	Benzene	0.001	J	0.001	J	MG/KG	LAKE POLY-3	1 / 193	0.0022 - 1	0.001	ND	1.2 c	No	BSL
50-00-0	Formaldehyde	0.096	J	1.3		MG/KG	SB-434	56 / 60	0.1 - 0.12	1.3	0.46	11 c	No	BSL
75-09-2	Methylene chloride	0.002	J	0.44	B	MG/KG	DB-C1 SD-C42B	6 / 193	0.004 - 2	0.44	ND	35 n	No	BSL
91-20-3	Naphthalene	0.16	J	0.16	J	MG/KG	SB-420	1 / 159	0.022 - 10	0.16	ND	3.8 c	No	BSL
100-42-5	Styrene	0.001	J	0.31		MG/KG	SB-420	2 / 193	0.0022 - 1	0.31	ND	600 n	No	BSL
127-18-4	Tetrachloroethene	0.001	J	0.015		MG/KG	SWMU-33-102	4 / 193	0.0022 - 1	0.015	ND	8.1 n	No	BSL
109-99-9	Tetrahydrofuran	0.007	J	0.009	J	MG/KG	SB-470	3 / 127	0.022 - 1.6	0.009	ND	1800 n	No	BSL
108-88-3	Toluene	0.0009	J	0.038		MG/KG	SWMU-33-102	8 / 193	0.0022 - 1	0.038	ND	490 n	No	BSL
79-01-6	Trichloroethene	0.007		0.007		MG/KG	A9CW-3	1 / 193	0.0022 - 1	0.007	ND	0.41 n	No	BSL
179601-23-1	Xylenes (m&p)	0.011		0.011		MG/KG	SWMU-33-102	1 / 165	0.0044 - 1	0.011	ND	58 n	No	BSL
1330-20-7	Xylenes, Total	0.002	J	0.011		MG/KG	SWMU-33-102	2 / 194	0.0044 - 1	0.011	ND	58 n	No	BSL
	Semivolatile Organics													
95-50-1	1,2-Dichlorobenzene	0.21	J	0.21	J	MG/KG	SS-439	1 / 217	0.033 - 36	0.21	ND	180 n	No	BSL
106-46-7	1,4-Dichlorobenzene	0.053	J	0.053	J	MG/KG	SS-439	1 / 217	0.033 - 36	0.053	ND	2.6 c	No	BSL
90-12-0	1-Methylnaphthalene	0.023	J	0.62		MG/KG	SB-447	8 / 136	0.033 - 23	0.62	ND	18 c	No	BSL
105-67-9	2,4-Dimethylphenol	0.61	J	0.61	J	MG/KG	SB-420	1 / 217	0.033 - 36	0.61	ND	130 n	No	BSL
51-28-5	2,4-Dinitrophenol	0.016	J	0.016	J	MG/KG	SB-417	1 / 199	0.033 - 160	0.016	ND	13 n	No	BSL
91-57-6	2-Methylnaphthalene	0.007	J	0.71		MG/KG	SB-447	12 / 226	0.033 - 36	0.71	ND	24 n	No	BSL
95-48-7	2-Methylphenol	0.02	J	3.1		MG/KG	SB-420	2 / 217	0.033 - 36	3.1	ND	320 n	No	BSL
15831-10-4	3 & 4 Methylphenol	1.5		1.5		MG/KG	SB-420	1 / 185	0.033 - 36	1.5	ND	320 n	No	BSL
99-09-2	3-Nitroaniline	0.073	J	0.073	J	MG/KG	SS-446	1 / 216	0.17 - 180	0.073	ND	25 n	No	BSL
83-32-9	Acenaphthene	0.1		4.8		MG/KG	SB-447	6 / 224	0.033 - 36	4.8	ND	360 n	No	BSL
208-96-8	Acenaphthylene	0.008	J	3.9		MG/KG	BS042	13 / 226	0.033 - 36	3.9	ND	180 n	No	BSL
98-86-2	Acetophenone	0.011	JEB	0.17	J	MG/KG	SS-445	15 / 141	0.033 - 23	0.17	ND	780 n	No	BSL
62-53-3	Aniline	0.016	J	0.69	J	MG/KG	SB-421	5 / 189	0.033 - 180	0.69	ND	44 n	No	BSL
120-12-7	Anthracene	0.005	J	9.1	EB	MG/KG	SB-447	22 / 225	0.033 - 36	9.1	ND	1800 n	No	BSL
100-52-7	Benzaldehyde	0.012	J	1.9		MG/KG	SB-435	45 / 136	0.033 - 23	1.9	0.10	170 c	No	BSL
56-55-3	Benzo(a)anthracene	0.008	J	28	J	MG/KG	SB-410 SB-447	53 / 221	0.033 - 17	28	0.019	1.1 c	Yes	ASL
50-32-8	Benzo(a)pyrene	0.011	J	21	J	MG/KG	SB-447	63 / 208	0.033 - 1.9	21	0.023	0.11 c	Yes	ASL
205-99-2	Benzo(b)fluoranthene	0.013	J	29	J	MG/KG	SB-447	61 / 221	0.033 - 17	29	0.053	1.1 c	Yes	ASL
191-24-2	Benzo(ghi)perylene	0.014	J	16	J	MG/KG	SB-447	44 / 225	0.033 - 36	16	0.024	180 n	No	BSL
207-08-9	Benzo(k)fluoranthene	0.011	J	12		MG/KG	SB-410	40 / 225	0.033 - 36	12	ND	11 c	Yes	ASL

Table 1
Data Summary and Selection of Chemicals of Potential Concern
Surface Soil (0-1 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection		Range of Reporting Limits for Non Detects			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection
65-85-0	Benzoic Acid	0.025	J	34	JEB	MG/KG	SB-453	29	/ 188	0.17	-	180	34	ND	25000	n	No	BSL
100-51-6	Benzyl alcohol	0.34		0.34		MG/KG	SB-474	1	/ 211	0.066	-	72	0.34	ND	630	n	No	BSL
92-52-4	Biphenyl	0.023	J	0.93	J	MG/KG	SB-528	11	/ 136	0.033	-	23	0.93	ND	4.7	n	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	0.011	JEB	375	C	MG/KG	BD-C31	167	/ 221	0.034	-	9.1	375	0.031	39	c	Yes	ASL
85-68-7	Butylbenzylphthalate	0.029	J	0.36		MG/KG	SB-402	7	/ 217	0.033	-	36	0.36	ND	290	c	No	BSL
86-74-8	Carbazole	0.02	J	5.4		MG/KG	SB-447	9	/ 140	0.033	-	23	5.4	ND	NBA		Yes	NSL
218-01-9	Chrysene	0.011	J	26	J	MG/KG	SB-410 SB-447	70	/ 225	0.033	-	36	26	0.028	110	c	No	BSL
53-70-3	Dibenz(a,h)anthracene	0.015	J	4.8	J	MG/KG	SB-410	18	/ 207	0.033	-	1.9	4.8	ND	0.11	c	Yes	ASL
132-64-9	Dibenzofuran	0.016	J	1.7		MG/KG	SB-447	12	/ 218	0.033	-	36	1.7	ND	7.3	n	No	BSL
84-66-2	Diethylphthalate	0.013	JB	0.085	JB	MG/KG	BS016	7	/ 217	0.021	-	36	0.085	ND	5100	n	No	BSL
131-11-3	Dimethylphthalate	0.064	J	0.11	J	MG/KG	SS-417	2	/ 217	0.033	-	36	0.11	ND	NBA		Yes	NSL
84-74-2	Di-n-butylphthalate	0.009	JB	3	JC	MG/KG	SD-C42B	18	/ 217	0.033	-	110	3	ND	630	n	No	BSL
117-84-0	Di-n-octylphthalate	0.012	J	0.053	J	MG/KG	AREA-7	3	/ 216	0.033	-	36	0.053	ND	63	n	No	BSL
101-84-8	Diphenyl ether	0.011	J	1.9	J	MG/KG	SB-528	20	/ 136	0.033	-	23	1.9	ND	3.4	n	No	BSL
122-39-4	Diphenylamine	0.0023	J	5		MG/KG	SB-421	17	/ 55	0.033	-	17	5	ND	630	n	No	BSL
206-44-0	Fluoranthene	0.01	J	73		MG/KG	SB-447	94	/ 226	0.033	-	36	73	0.044	240	n	No	BSL
86-73-7	Fluorene	0.008	J	3.5		MG/KG	SB-447	11	/ 224	0.033	-	36	3.5	ND	240	n	No	BSL
118-74-1	Hexachlorobenzene	0.018	J	0.018	J	MG/KG	SB-446	1	/ 211	0.033	-	36	0.018	ND	0.21	c	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	0.011	J	14	J	MG/KG	SB-447	48	/ 220	0.033	-	17	14	0.033	1.1	c	Yes	ASL
91-20-3	Naphthalene	0.008	J	0.96		MG/KG	SB-447	19	/ 226	0.036	-	41	0.96	ND	3.8	c	No	BSL
621-64-7	N-Nitrosodi-n-propylamine	0.26	J	0.26	J	MG/KG	SS-445	1	/ 218	0.033	-	36	0.26	ND	0.078	c	Yes	ASL
86-30-6	N-Nitrosodiphenylamine	0.012	JEB	2.8	J	MG/KG	BS015	38	/ 219	0.033	-	36	2.8	ND	110	c	No	BSL
87-86-5	Pentachlorophenol	0.032	J	0.045		MG/KG	SB-452	2	/ 213	0.033	-	180	0.045	ND	1.0	c	No	BSL
85-01-8	Phenanthrene	0.011	J	35		MG/KG	SB-447	69	/ 226	0.036	-	36	35	0.036	180	n	No	BSL
108-95-2	Phenol	0.014	J	32	J	MG/KG	SB-420	10	/ 218	0.033	-	36	32	ND	1900	n	No	BSL
129-00-0	Pyrene	0.011	J	29		MG/KG	SB-410	89	/ 225	0.033	-	36	29	0.050	180	n	No	BSL
	Pesticides																	
72-54-8	4,4'-DDD	0.00012	J	0.16		MG/KG	BS045	8	/ 49	0.0033	-	0.21	0.16	NA	0.19	n	No	BSL
72-55-9	4,4'-DDE	0.00053	J	0.049	J	MG/KG	AREA-4	13	/ 49	0.0033	-	0.21	0.049	NA	2.0	c	No	BSL
50-29-3	4,4'-DDT	0.0014	J	0.68	J	MG/KG	AREA-4	24	/ 49	0.0033	-	0.21	0.68	NA	1.9	c	No	BSL
309-00-2	Aldrin	0.000098	J	0.003	J	MG/KG	SWMU-26	3	/ 49	0.0017	-	0.21	0.003	NA	0.039	c	No	BSL
319-84-6	Alpha-BHC	0.0002	J	0.0058	J	MG/KG	BS015	3	/ 49	0.0017	-	0.21	0.0058	NA	0.086	c	No	BSL
5103-71-9	Alpha-Chlordane	0.00034	J	0.0034		MG/KG	LAKE POLY-2	3	/ 25	0.0017	-	0.24	0.0034	NA	1.7	c	No	BSL
319-85-7	Beta-BHC	0.00013	J	0.00013	J	MG/KG	AREA-8-2	1	/ 49	0.0017	-	0.33	0.00013	NA	0.30	c	No	BSL
12789-03-6	Chlordane (technical)	0.00028	J	0.036		MG/KG	DB-C1	4	/ 25	0.0017	-	0.24	0.036	NA	1.7	c	No	BSL
319-86-8	Delta-BHC	0.0015	J	0.031	#	MG/KG	DB-C1	2	/ 49	0.0017	-	0.21	0.031	NA	NBA		Yes	NSL
60-57-1	Dieldrin	0.00055	J	0.0025	J	MG/KG	BS018	8	/ 49	0.0033	-	0.68	0.0025	NA	0.034	c	No	BSL
959-98-8	Endosulfan I	0.0021	J	0.034		MG/KG	BS042	3	/ 49	0.0017	-	0.21	0.034	NA	47	n	No	BSL
72-20-8	Endrin	0.0004	J	0.0072	J	MG/KG	SWMU-26	2	/ 49	0.0033	-	0.21	0.0072	NA	1.9	n	No	BSL
53494-70-5	Endrin ketone	0.0014	J	0.0014	J	MG/KG	BS019	1	/ 31	0.0033	-	0.065	0.0014	NA	1.9	n	No	BSL
58-89-9	Gamma-BHC/Lindane	0.00011	J	0.14		MG/KG	SWMU-26	7	/ 49	0.0017	-	0.21	0.14	NA	0.57	c	No	BSL
1024-57-3	Heptachlor epoxide	0.000078	J	0.00041	J	MG/KG	BS020	2	/ 49	0.0017	-	0.21	0.00041	NA	0.070	c	No	BSL
118-74-1	Hexachlorobenzene	0.029		0.029		MG/KG	BS040	1	/ 6	0.024	-	0.044	0.029	NA	0.21	c	No	BSL
12674-11-2	Aroclor-1016	0.98	J	0.98	J	MG/KG	SWMU-33	1	/ 42	0.000094	-	1	0.98	NA	0.41	n	Yes	ASL
11096-82-5	Aroclor-1260	0.024	J	13		MG/KG	SS-403	12	/ 42	0.1	-	1	13	NA	0.24	c	Yes	ASL

Table 1
Data Summary and Selection of Chemicals of Potential Concern
Surface Soil (0-1 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection
	Inorganics																
7429-90-5	Aluminum	640		59000		MG/KG	SWMU-33	156 / 156				59000	16279	7700	n	Yes	ASL
7440-36-0	Antimony	0.28	J	79		MG/KG	SWMU-33	8 / 142	0.53	-	20	79	ND	3.1	n	Yes	ASL
7440-38-2	Arsenic	1.3		56		MG/KG	SB-451	156 / 173	0.9	-	37	56	11.7	0.68	c	Yes	ASL
7440-39-3	Barium	3.4		130	J	MG/KG	SS-445	161 / 161				130	17.7	1500	n	No	BSL
7440-41-7	Beryllium	0.029	J	4		MG/KG	SWMU-33	119 / 143	0.18	-	1.5	4	0.40	16	n	No	BSL
7440-43-9	Cadmium	0.026	J	5.8		MG/KG	SWMU-33	118 / 179	0.1	-	4	5.8	0.32	7.1	n	No	BSL
7440-70-2	Calcium	68		35000		MG/KG	SS-425	144 / 144				35000	680	NBA		No	E
7440-47-3	Chromium	1.1		62000		MG/KG	SOLSD06	248 / 250	5	-	10	62000	12.8	12000	n	Yes	ASL
18540-29-9	Chromium, Hexavalent	0.29	J	1100		MG/KG	SS-445	26 / 73	0.23	-	110	1100	ND	0.30	c	Yes	ASL
7440-48-4	Cobalt	0.16	J	45.5		MG/KG	BS041	141 / 144	0.24	-	5.4	45.5	3.4	2.3	n	Yes	ASL
7440-50-8	Copper	0.94	JEB	190	J	MG/KG	SS-445	143 / 144	1		1	190	6.7	310	n	No	BSL
7439-89-6	Iron	81		100000		MG/KG	SWMU-33	156 / 156				100000	15564	5500	n	Yes	ASL
7439-92-1	Lead	1.1		210		MG/KG	AREA-9	176 / 180	5	-	11	210	28	200	L	Yes	ASL
7439-95-4	Magnesium	24		6000		MG/KG	SB-431	144 / 144				6000	1215	NBA		No	E
7439-96-5	Manganese	2.8		1035		MG/KG	BS041	144 / 144				1035	75	180	n	Yes	ASL
7439-97-6	Mercury	0.01		3.1	J	MG/KG	SS-445	67 / 173	0.04	-	0.76	3.1	0.12	2.3	n	Yes	ASL
7440-02-0	Nickel	0.66	J	76		MG/KG	SB-439	143 / 144	5	-	5	76	8.4	150	n	No	BSL
7440-09-7	Potassium	46.3	BE	3400		MG/KG	SS-412	137 / 144	220	-	2100	3400	682	NBA		No	E
7782-49-2	Selenium	0.93		3.6		MG/KG	SB-435	6 / 170	0.5	-	20	3.6	0.70	39	n	No	BSL
7440-22-4	Silver	0.064	J	1100	J	MG/KG	SS-445	55 / 158	0.2	-	21	1100	ND	39	n	Yes	ASL
7440-23-5	Sodium	15	J	2250		MG/KG	BS041	88 / 142	66	-	1100	2250	50	NBA		No	E
7440-28-0	Thallium	0.09	JEB	7.4	J	MG/KG	SS-445	7 / 143	0.35	-	6.5	7.4	ND	0.078	n	Yes	ASL
7440-31-5	Tin	1	J	26000	J	MG/KG	SS-445	105 / 115	5.4	-	7.5	26000	4.4	4700	n	Yes	ASL
7440-62-2	Vanadium	3.6		240		MG/KG	SB-447	144 / 144				240	25	39	n	Yes	ASL
7440-66-6	Zinc	1.2	J	650		MG/KG	SB-447	139 / 144	11	-	27	650	19.6	2300	n	No	BSL
16887-00-6	Chloride	25		560	J	MG/KG	SWMU-33	18 / 126	15	-	81	560	ND	NBA		Yes	NSL
HLA0226	Cyanide, Available	3.75		3.75		MG/KG	BS041	1 / 6	2	-	4.1	3.75	NA	NBA		Yes	NSL
57-12-5	Cyanide, Total	3.7		9.05		MG/KG	BS041	7 / 13	2	-	2	9.05	NA	2.3	n	Yes	ASL
HLA0043	Nitrogen, as Ammonia	6.8		2100		MG/KG	SB-434	128 / 146	5.7	-	8.4	2100	ND	NBA		Yes	NSL
14808-79-8	Sulfate	4.2	J	23900		MG/KG	CPDA-8	54 / 137	31	-	210	23900	NC	NBA		Yes	NSL
	VPH																
HLA0156	C9-C10 Aromatics	3.4	J	3.4	J	MG/KG	SB-432	1 / 25	2	-	4	3.4	NA	100		No	BSL
	EPH																
HLA0108	C11-C22 Aromatics	4.5		7500		MG/KG	SDF-1	32 / 48	3.4	-	4.3	7500	NA	1000		Yes	ASL
HLA0109	C19-C36 Aliphatics	3.6		4900		MG/KG	SDF-1	26 / 48	3.4	-	350	4900	NA	3000		Yes	ASL
HLA0113	C9-C18 Aliphatics	3.6		780	J	MG/KG	SDF-1	9 / 48	3.3	-	350	780	NA	1000		No	BSL
	Specialty Compounds																
302-01-2	Hydrazine	0.00062	J	0.27		MG/KG	SB-468	16 / 58	0.002	-	0.28	0.27	ND	0.032	c	Yes	ASL
85-44-9	Phthalic Acid/Phthalic anhydrid	0.022	J	29		MG/KG	SB-420	10 / 57	0.096	-	0.56	29	ND	13000	n	No	BSL

Table 1
Data Summary and Selection of Chemicals of Potential Concern
Surface Soil (0-1 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)	Maximum (1) Concentration (Qualifier)	Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)	Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection

(1) Minimum or maximum concentration detected in data set. Samples included in data set are identified in Olin's OU1/OU2 HHRA 2015, Appendix M, Attachment 2.
(2) The concentration used for screening is the maximum detected concentration.
(3) Background value is the site specific background upper prediction limit concentration.
(4) Values are the Regional Screening Levels (RSLs) obtained from USEPA dated November 2019 for residential soils, HQ=0.1 or MCP S-1 values.
Values used for screening are the residential soil RSLs for the lesser of cancer risks equal to 1E-06 or non-cancer risks equal to a hazard index of 0.1.
RSL for 2,4,4-Trimethyl-1-pentene and 2,4,4-Trimethyl-2-pentene calculated by Olin consistent with RSL Guidance (AMEC, 2015 - OU1/OU2 HHRA Attachment 6).
RSL for m-cresol used for 3 & 4 Methylphenol.
RSL for 4-Nitroaniline used for 3-Nitroaniline.
RSL for pyrene used for phenanthrene, acenaphthylene, benzo(ghi)perylene.
RSL for chlordane used for Alpha-Chlordane.
RSL for Endosulfan used for Endosulfan I and Endosulfan II.
RSL for Endrin used for Endrin Ketone.
RSL for Chromium (III) used for chromium.
RSL for Mercuric chloride used for mercury.
RSL for Vanadium and compounds used for vanadium.
n - RSL is based on a non-cancer hazard quotient of 0.1.
c - RSL is based on an excess lifetime cancer risk of 1 in 1 million. c* - where n RSL < 100X c RSL.
n[a] - Value is based on a non-cancer endpoint because RSL at a hazard index of 0.1 is lower than RSL at cancer risk equal to 1E-06.
ns - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed Csat.
nm - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed ceiling limit.
L - see EPA Region I guidance on lead.
Screening values for EPH and VPH fractions are the MCP S-1 values, which are based on ceiling values.

(5) Analyte is selected as a COPC if the concentration used for screening exceeds the screening value or if no screening value is available.
ASL - Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
BSL - Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
NSL - No screening level available; the anlayte was selected as a COPC.
E - Compound is an essential nutrient.
mg/Kg - milligrams per kilogram.
COPC - Chemical of potential concern.
B - The reported result is attributed to laboratory contamination due to the presence of the chemical in the associated blank (GEI).
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.

Table 2
Data Summary and Selection of Chemicals of Potential Concern
Subsurface Soil (1-10 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection
	Volatile Organics														
87-61-6	1,2,3-Trichlorobenzene	0.44		0.44		MG/KG	LPB10	1 / 124	0.002 - 11	0.44	ND	6.3	n	No	BSL
120-82-1	1,2,4-Trichlorobenzene	0.0016	J	0.0016	J	MG/KG	SB-465	1 / 124	0.002 - 11	0.0016	ND	5.8	n	No	BSL
95-63-6	1,2,4-Trimethylbenzene	0.39		0.68	J	MG/KG	LAKEPOLY1-02	2 / 124	0.002 - 11	0.68	ND	30	n	No	BSL
95-50-1	1,2-Dichlorobenzene	0.16		0.16		MG/KG	LPB12	1 / 124	0.002 - 11	0.16	ND	180	n	No	BSL
107-06-2	1,2-Dichloroethane	0.002	J	0.035		MG/KG	BH26	2 / 172	0.002 - 35	0.035	ND	0.46	c	No	BSL
108-67-8	1,3,5-Trimethylbenzene	0.11	J	0.11	J	MG/KG	LPB10	1 / 124	0.002 - 11	0.11	ND	27	n	No	BSL
106-46-7	1,4-Dichlorobenzene	0.27		0.27		MG/KG	LPB12	1 / 124	0.002 - 11	0.27	ND	2.6	c	No	BSL
107-39-1	2,4,4-Trimethyl-1-pentene	0.0016	J	1200	J	MG/KG	SB-405	53 / 181	0.004 - 0.28	1200	ND	0.8	n	Yes	ASL
107-40-4	2,4,4-Trimethyl-2-pentene	0.001	J	310		MG/KG	SB-405	47 / 181	0.004 - 1.6	310	ND	0.8	n	Yes	ASL
78-93-3	2-Butanone	0.0006	J	0.033	J	MG/KG	SB-403	11 / 172	0.01 - 110	0.033	ND	2700	n	No	BSL
591-78-6	2-Hexanone	0.001	J	3.8		MG/KG	BH15	10 / 172	0.01 - 110	3.8	ND	20	n	No	BSL
99-87-6	4-iso-Propyltoluene	0.46		5.2		MG/KG	LPB10	5 / 124	0.002 - 11	5.2	ND	NBA		Yes	NSL
108-10-1	4-Methyl-2-pentanone	0.005	J	0.027	J	MG/KG	BH26	3 / 172	0.01 - 110	0.027	ND	3300	n	No	BSL
75-07-0	Acetaldehyde	0.037	J	0.1	J	MG/KG	SB-457	10 / 66	0.2 - 0.37	0.1	ND	8.2	n	No	BSL
67-64-1	Acetone	0.016		22	J	MG/KG	B-10	16 / 172	0.01 - 1100	22	0.037	6100	n	No	BSL
71-43-2	Benzene	0.0005	J	0.012	J	MG/KG	BH18	2 / 185	0.002 - 11	0.012	ND	1.2	c	No	BSL
75-15-0	Carbon disulfide	0.001	J	0.0023	J	MG/KG	SB-409 SB-423	5 / 143	0.0021 - 35	0.0023	ND	77	n	No	BSL
56-23-5	Carbon tetrachloride	0.009	J	0.009	J	MG/KG	BH26	1 / 172	0.002 - 35	0.009	ND	0.65	c	No	BSL
108-90-7	Chlorobenzene	0.017	J	0.017	J	MG/KG	BH26	1 / 172	0.002 - 35	0.017	ND	28	n	No	BSL
67-66-3	Chloroform	0.001	J	0.007	J	MG/KG	BH26	3 / 172	0.002 - 35	0.007	ND	0.32	c	No	BSL
74-87-3	Chloromethane	0.28	J	0.28	J	MG/KG	DA-C25	1 / 172	0.004 - 35	0.28	ND	11	n	No	BSL
100-41-4	Ethyl benzene	0.002	J	6.7		MG/KG	LPB8	12 / 185	0.002 - 11	6.7	ND	5.8	c	Yes	ASL
50-00-0	Formaldehyde	0.0935	J	2.1		MG/KG	SB-409	55 / 66	0.11 - 0.13	2.1	0.46	11	c	No	BSL
75-09-2	Methylene chloride	0.002	JB	0.0074	J	MG/KG	SB-410	3 / 172	0.005 - 46	0.0074	ND	35	n	No	BSL
100-42-5	Styrene	0.0005	J	3.3		MG/KG	BH15	4 / 172	0.002 - 35	3.3	ND	600	n	No	BSL
127-18-4	Tetrachloroethene	0.0008	J	0.014	J	MG/KG	BH26	6 / 172	0.002 - 35	0.014	ND	8.1	n	No	BSL
109-99-9	Tetrahydrofuran	0.007	J	0.0078	J	MG/KG	SB-470	3 / 87	0.02 - 110	0.0078	ND	1800	n	No	BSL
108-88-3	Toluene	0.0006	J	5.15		MG/KG	B-10	21 / 185	0.002 - 11	5.15	ND	490	n	No	BSL
79-01-6	Trichloroethene	0.007		0.022	J	MG/KG	BH26	3 / 172	0.002 - 35	0.022	ND	0.41	n	No	BSL
95-47-6	Xylene, o	0.15	J	0.15	J	MG/KG	BD-C20	1 / 129	0.002 - 11	0.15	ND	65	n	No	BSL
179601-23-1	Xylenes (m&p)	0.2		0.5		MG/KG	BD-C20	2 / 129	0.004 - 23	0.5	ND	58	n	No	BSL
1330-20-7	Xylenes, Total	0.003	J	4.6		MG/KG	LPB8	8 / 184	0.004 - 23	4.6	ND	58	n	No	BSL
	Semivolatile Organics														
120-82-1	1,2,4-Trichlorobenzene	0.088	J	0.088	J	MG/KG	LPB-2	1 / 186	0.033 - 670	0.088	ND	5.8	n	No	BSL
95-50-1	1,2-Dichlorobenzene	0.17	J	0.17	J	MG/KG	LPB-2	1 / 186	0.033 - 670	0.17	ND	180	n	No	BSL
106-46-7	1,4-Dichlorobenzene	0.23	J	0.23	J	MG/KG	LPB-2	1 / 186	0.033 - 670	0.23	ND	2.6	c	No	BSL
90-12-0	1-Methylnaphthalene	0.031	J	0.031	J	MG/KG	SB-460	1 / 92	0.033 - 37	0.031	ND	18	c	No	BSL
105-67-9	2,4-Dimethylphenol	1.8		1.8		MG/KG	BD-C5	1 / 186	0.033 - 670	1.8	ND	130	n	No	BSL
91-57-6	2-Methylnaphthalene	0.049		0.063	J	MG/KG	BH12	2 / 197	0.033 - 670	0.063	ND	24	n	No	BSL
15831-10-4	3 & 4 Methylphenol	0.13	J	0.13	J	MG/KG	SB-447	1 / 131	0.033 - 79	0.13	ND	320	n	No	BSL
7005-72-3	4-Chlorophenyl phenyl ether	0.17	J	0.17	J	MG/KG	LPB-2	1 / 186	0.033 - 670	0.17	ND	NBA		Yes	NSL
83-32-9	Acenaphthene	0.014	J	6.2		MG/KG	AS-4	3 / 197	0.033 - 670	6.2	ND	360	n	No	BSL
208-96-8	Acenaphthylene	0.014	J	0.88		MG/KG	B-10	3 / 197	0.033 - 670	0.88	ND	180	n	No	BSL
98-86-2	Acetophenone	0.034	JEB	1.5	JEB	MG/KG	SB-447	3 / 92	0.033 - 37	1.5	ND	780	n	No	BSL
62-53-3	Aniline	0.089	J	0.089	J	MG/KG	SB-427	1 / 139	0.033 - 400	0.089	ND	44	n	No	BSL
120-12-7	Anthracene	0.012	JEB	7.6	C	MG/KG	RSO-06-N	4 / 197	0.033 - 670	7.6	ND	1800	n	No	BSL

Table 2
Data Summary and Selection of Chemicals of Potential Concern
Subsurface Soil (1-10 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection			Range of Reporting Limits for Non Detects			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection
100-52-7	Benzaldehyde	0.014	J	0.014	J	MG/KG	SB-424	1	/	92	0.033	-	37	0.014	0.10	170	c	No	BSL
56-55-3	Benzo(a)anthracene	0.02	J	18	C	MG/KG	RSO-06-N	11	/	194	0.033	-	21	18	0.019	1.1	c	Yes	ASL
50-32-8	Benzo(a)pyrene	0.019	J	23	C	MG/KG	RSO-06-N	7	/	190	0.033	-	1.2	23	0.023	0.11	c	Yes	ASL
205-99-2	Benzo(b)fluoranthene	0.029	J	17	C	MG/KG	RSO-06-N	9	/	193	0.033	-	21	17	0.053	1.1	c	Yes	ASL
191-24-2	Benzo(ghi)perylene	0.049		9.5	C	MG/KG	RSO-06-N	8	/	197	0.033	-	670	9.5	0.024	180	n	No	BSL
207-08-9	Benzo(k)fluoranthene	0.013	J	21	C	MG/KG	RSO-06-N	4	/	195	0.033	-	48	21	ND	11	c	Yes	ASL
65-85-0	Benzoic Acid	0.022	J	0.19	J	MG/KG	SB-496	11	/	154	0.17	-	400	0.19	ND	25000	n	No	BSL
92-52-4	Biphenyl	0.017	J	0.77	J	MG/KG	SB-447	5	/	92	0.033	-	37	0.77	ND	4.7	n	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	0.012	JEB	8600		MG/KG	SB-477	104	/	186	0.034	-	1.4	8600	0.031	39	c	Yes	ASL
85-68-7	Butylbenzylphthalate	0.034	J	2.2		MG/KG	BH12	9	/	186	0.033	-	670	2.2	ND	290	c	No	BSL
86-74-8	Carbazole	0.017	J	0.017	J	MG/KG	SB-414	1	/	114	0.033	-	670	0.017	ND	NBA		Yes	NSL
218-01-9	Chrysene	0.012	J	18	C	MG/KG	RSO-06-N	8	/	198	0.033	-	670	18	0.028	110	c	No	BSL
53-70-3	Dibenz(a,h)anthracene	0.15		0.15		MG/KG	SB-412	1	/	189	0.033	-	1.2	0.15	ND	0.11	c	Yes	ASL
132-64-9	Dibenzofuran	0.022	J	0.11	J	MG/KG	BH12	3	/	186	0.033	-	670	0.11	ND	7.3	n	No	BSL
84-66-2	Diethylphthalate	0.046	J	0.057	J	MG/KG	BH18	2	/	186	0.033	-	670	0.057	ND	5100	n	No	BSL
84-74-2	Di-n-butylphthalate	0.032	JB	33	JC	MG/KG	BD-C20	10	/	186	0.033	-	670	33	ND	630	n	No	BSL
117-84-0	Di-n-octylphthalate	0.021	J	10.95		MG/KG	SB-475	12	/	186	0.033	-	670	10.95	ND	63	n	No	BSL
101-84-8	Diphenyl ether	0.03	J	3.8	J	MG/KG	SB-447	8	/	92	0.033	-	37	3.8	ND	3.4	n	Yes	ASL
122-39-4	Diphenylamine	0.0225	J	0.25		MG/KG	SB-424	6	/	41	0.034	-	0.54	0.25	ND	630	n	No	BSL
206-44-0	Fluoranthene	0.015	J	37	C	MG/KG	RSO-06-N	13	/	197	0.033	-	670	37	0.044	240	n	No	BSL
86-73-7	Fluorene	0.012	J	2.7		MG/KG	B-10	4	/	198	0.033	-	670	2.7	ND	240	n	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	0.012	J	10	C	MG/KG	LPB8 RSO-06-N	11	/	194	0.033	-	21	10	0.033	1.1	c	Yes	ASL
91-20-3	Naphthalene	0.012	J	0.77		MG/KG	AS-4	6	/	196	0.035	-	89	0.77	ND	3.8	c	No	BSL
86-30-6	N-Nitrosodiphenylamine	0.011	JEB	3400		MG/KG	BH12	30	/	186	0.033	-	48	3400	ND	110	c	Yes	ASL
85-01-8	Phenanthrene	0.015	J	33	C	MG/KG	RSO-06-N	14	/	197	0.035	-	670	33	0.036	180	n	No	BSL
108-95-2	Phenol	0.055	J	1.5		MG/KG	SB-462	4	/	186	0.033	-	670	1.5	ND	1900	n	No	BSL
129-00-0	Pyrene	0.015	J	35	C	MG/KG	RSO-06-N	16	/	197	0.033	-	670	35	0.050	180	n	No	BSL
	Pesticide/PCBs																		
72-54-8	4,4'-DDD	0.04		0.04		MG/KG	BH12	1	/	65	0.0099	-	0.059	0.04	NA	0.19	n	No	BSL
309-00-2	Aldrin	0.032		0.032		MG/KG	BH12	1	/	65	0.0099	-	0.059	0.032	NA	0.039	c	No	BSL
319-84-6	Alpha-BHC	0.024		0.024		MG/KG	BH12	1	/	65	0.0099	-	0.059	0.024	NA	0.086	c	No	BSL
1031-07-8	Endosulfan sulfate	0.15		0.15		MG/KG	BH12	1	/	65	0.0099	-	0.059	0.15	NA	38	n	No	BSL
72-20-8	Endrin	0.089		0.089		MG/KG	BH12	1	/	65	0.0099	-	0.059	0.089	NA	1.9	n	No	BSL
11096-82-5	Aroclor-1260	0.019		10		MG/KG	SB-530	5	/	40	0.0001	-	0.59	10	NA	0.24	c	Yes	ASL
	Inorganics																		
7429-90-5	Aluminum	200		15000		MG/KG	SB-455	136	/	136				15000	16279	7700	n	Yes	ASL
7440-36-0	Antimony	0.26	J	41		MG/KG	BH12	11	/	125	0.5	-	20	41	ND	3.1	n	Yes	ASL
7440-38-2	Arsenic	0.5	J	16		MG/KG	SB-418 SB-469	103	/	129	0.81	-	13	16	11.7	0.68	c	Yes	ASL
7440-39-3	Barium	2.2	J	75		MG/KG	BH13	120	/	123	11	-	40	75	17.7	1500	n	No	BSL
7440-41-7	Beryllium	0.037	J	0.47		MG/KG	SB-431	82	/	125	0.06	-	1.5	0.47	0.40	16	n	No	BSL
7440-43-9	Cadmium	0.019	J	1.2		MG/KG	BH5	79	/	159	0.1	-	3	1.2	0.32	7.1	n	No	BSL
7440-70-2	Calcium	150		23000		MG/KG	E1.40	116	/	117	1000	-	1000	23000	680	NBA		No	E
7440-47-3	Chromium	1.8		7900		MG/KG	LP-C08 LPB18	225	/	227	1	-	11	7900	12.8	12000	n	No	BSL
18540-29-9	Chromium, Hexavalent	0.17	J	19.9	T	MG/KG	LP-101	20	/	31	0.23	-	2.5	19.9	NA	0.3	c	Yes	ASL

Table 2
Data Summary and Selection of Chemicals of Potential Concern
Subsurface Soil (1-10 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection			Range of Reporting Limits for Non Detects			Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection
7440-48-4	Cobalt	0.29	J	14		MG/KG	SB-405 SB-431	107	/	117	1.5	-	10	14	3.4	2.3	n	Yes	ASL
7440-50-8	Copper	0.46	J	45		MG/KG	SB-424	107	/	125	2	-	20	45	6.7	310	n	No	BSL
7439-89-6	Iron	160		26000		MG/KG	SB-431	128	/	128				26000	15564	5500	n	Yes	ASL
7439-92-1	Lead	0.73	J	50		MG/KG	BD-C35	115	/	159	1	-	13	50	28	200	L	No	BSL
7439-95-4	Magnesium	63	J	6700		MG/KG	SB-405 SB-431	115	/	117	1000	-	1000	6700	1215	NBA		No	E
7439-96-5	Manganese	5.8		340		MG/KG	BH13	117	/	117				340	75	180	n	Yes	ASL
7439-97-6	Mercury	0.029	J	7		MG/KG	LPB10	16	/	141	0.04	-	0.22	7	0.12	2.3	n	Yes	ASL
7440-02-0	Nickel	0.93	J	52		MG/KG	SB-447	112	/	125	1.4	-	8	52	8.4	150	n	No	BSL
7440-09-7	Potassium	130		2700		MG/KG	SB-469	115	/	117	1000	-	1000	2700	682	NBA		No	E
7782-49-2	Selenium	0.73	J	0.73	J	MG/KG	SB-403	1	/	141	0.5	-	13	0.73	0.70	39	n	No	BSL
7440-22-4	Silver	0.06	J	24		MG/KG	SB-448	23	/	131	0.5	-	13	24	ND	39	n	No	BSL
7440-23-5	Sodium	12		25600		MG/KG	E1.45	79	/	126	54	-	290	25600	50	NBA		No	E
7440-28-0	Thallium	0.15	JEB	0.15	JEB	MG/KG	SB-420 SB-447	2	/	125	0.33	-	2.9	0.15	ND	0.078	n	Yes	ASL
7440-31-5	Tin	2.2	J	620	J	MG/KG	SB-448	49	/	69	5.8	-	7.3	620	4.4	4700	n	No	BSL
7440-62-2	Vanadium	0.89	J	190		MG/KG	SB-447	113	/	117	1	-	10	190	25	39	n	Yes	ASL
7440-66-6	Zinc	2.9	J	61		MG/KG	RSO-09	124	/	125	0.6	-	0.6	61	19.6	2300	n	No	BSL
16887-00-6	Chloride	1.03		170	J	MG/KG	BH23	23	/	109	17	-	40	170	ND	NBA		Yes	NSL
57-12-5	Cyanide, Total	2.3	J	5.4	J	MG/KG	BH17	2	/	25	2	-	2	5.4	NA	2.3	n	Yes	ASL
14797-55-8	Nitrate as N	14	J	24	J	MG/KG	BH25	2	/	2				24	NA	13000	n	No	BSL
HLA0043	Nitrogen, as Ammonia	3.6	J	4700	J	MG/KG	LP-BOT-C	103	/	142	5.4		8.3	4700	ND	NBA		Yes	NSL
14808-79-8	Sulfate	23	J	285000		MG/KG	B-1A E1.40	38	/	108	20	-	64	285000	NC	NBA		Yes	NSL
57-13-6	Urea	220		350		MG/KG	SVE-13	2	/	5	20	-	20	350	NA	NBA		Yes	NSL
	VPH																		
HLA0155	C5-C8 Aliphatics	4		400		MG/KG	SB-477	16	/	56	1.02	-	28	400	NA	100		Yes	ASL
HLA0156	C9-C10 Aromatics	2.8		110		MG/KG	SB-459	16	/	56	0.34	-	26	110	NA	100		Yes	ASL
HLA0154	C9-C12 Aliphatics	2.7		27		MG/KG	SB-477	6	/	56	0.34	-	28	27	NA	1000		No	BSL
	EPH																		
HLA0108	C11-C22 Aromatics	3.7		4700		MG/KG	SB-432	41	/	62	3.3	-	17	4700	ND	1000		Yes	ASL
HLA0109	C19-C36 Aliphatics	5.1		2450		MG/KG	SB-475	26	/	62	3.3	-	36	2450	ND	3000		No	BSL
HLA0113	C9-C18 Aliphatics	5.3		380	K	MG/KG	LPB10	32	/	62	3.3	-	36	380	ND	1000		No	BSL
	Specialty Compounds																		
302-01-2	Hydrazine	0.00058	J	1.9	Q	MG/KG	LPB-48	25	/	63	0.0021	-	0.35	1.9	ND	0.032	c	Yes	ASL
85-44-9	Phthalic Acid/Phthalic anhydride	0.041	J	0.041	J	MG/KG	SB-432	1	/	41	0.1	-	0.16	0.041	ND	13000	n	No	BSL

Table 2
Data Summary and Selection of Chemicals of Potential Concern
Subsurface Soil (1-10 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)	Maximum (1) Concentration (Qualifier)	Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)	Retain as COPC? (5)	Rationale for Contaminant Deletion or Selection

(1) Minimum or maximum concentration detected in data set. Samples included in data set are identified in Olin's OU1/OU2 HHRA 2015, Appendix M, Attachment 2.
(2) The concentration used for screening is the maximum detected concentration.
(3) Background value is the site specific background upper prediction limit concentration.
(4) Values are the Regional Screening Levels (RSLs) obtained from USEPA dated November 2019 for residential soils, HQ=0.1 or MCP S-1 values.
Values used for screening are the residential soil RSLs for the lesser of cancer risks equal to 1E-06 or non-cancer risks equal to a hazard index of 0.1.
RSL for 2,4,4-Trimethyl-1-pentene and 2,4,4-Trimethyl-2-pentene calculated by Olin consistent with RSL Guidance (AMEC, 2015 - OU1/OU2 HHRA Attachment 6).
RSL-for m-cresol used for 3 & 4 Methylphenol.
RSL for pyrene used for phenanthrene, acenaphthylene, benzo(ghi)perylene.
RSL for chlordane used for Alpha-chlordane.
RSL for Endosulfan used for endosulfan sulfate.
RSL for Chromium (III) used for chromium.
RSL for Mercuric chloride used for mercury.
RSL for Vanadium and compounds used for vanadium.
c - RSL is based on an excess lifetime cancer risk of 1 in 1 million.
c* - where n RSL < 100X c RSL.
n - RSL is based on a non-cancer hazard quotient of 0.1.
nm - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed ceiling limit.
nms - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed Csat and the ceiling limit.
ns - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed Csat.
L - see EPA Region I guidance on lead.
R - Relative bioavailability factor applied.
Screening values for EPH and VPH fractions are the MCP S-1 values, which are based on ceiling values.

(5) Analyte is selected as a COPC if the concentration used for screening exceeds the screening value or if no screening value is available.
ASL = Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
BSL = Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
NSL = No screening level available; the anlayte was selected as a COPC.
E = Compound is an essential nutrient.
mg/Kg - milligrams per kilogram.
COPC - Chemical of potential concern.
B - The reported result is attributed to laboratory contamination due to the presence of the chemical in the associated blank (GEI).
C - The result is estimated due to surrogate recovery outside of control limits (GEI).
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.
K - The result is estimated due to blank spike compound recovery outside the control limits (GEI).
Q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
T - The associated value is an estimated quantity and may be biased high due to the oxidation of Cr+3 to Cr+6.

Table 3
Exposure Point Concentrations, Residential Human Health Hazards, and Residential Cancer Risks
Surface Soil (0-1 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Exposure Point Concentration (1) (Qualifier)		Units	Non-cancer RSL HQ=1(2)	Cancer RSL (3)	Hazard Quotient/Index	Cancer Risk
	Volatile Organics							
107-39-1	2,4,4-Trimethyl-1-pentene	2.1		MG/KG	8	---	0.26	
	Semivolatile Organics							
56-55-3	Benzo(a)anthracene	28	J	MG/KG	---	1.1		2.5E-05
50-32-8	Benzo(a)pyrene	21	J	MG/KG	18	0.11	1.17	1.9E-04
205-99-2	Benzo(b)fluoranthene	29	J	MG/KG	---	1.1		2.6E-05
207-08-9	Benzo(k)fluoranthene	12		MG/KG	---	11		1.1E-06
117-81-7	Bis(2-Ethylhexyl)phthalate	375	C	MG/KG	1300	39	0.29	9.6E-06
86-74-8	Carbazole	5.4		MG/KG	---	---		
53-70-3	Dibenz(a,h)anthracene	4.8	J	MG/KG	---	0.11		4.4E-05
131-11-3	Dimethylphthalate	0.11	J	MG/KG	---	---		
193-39-5	Indeno(1,2,3-cd)pyrene	14	J	MG/KG	---	1.1		1.3E-05
621-64-7	N-Nitrosodi-n-propylamine	0.26	J	MG/KG	---	0.078		3.3E-06
	Pesticides							
319-86-8	Delta-BHC	0.031	#	MG/KG	---	---		
12674-11-2	Aroclor-1016	0.98	J	MG/KG	4.1	6.6	0.24	1.5E-07
11096-82-5	Aroclor-1260	13		MG/KG	---	0.24		5.4E-05
	Inorganics							
7429-90-5	Aluminum	59000		MG/KG	77000	---	0.77	
7440-36-0	Antimony	79		MG/KG	31	---	2.55	
7440-38-2	Arsenic	56		MG/KG	35	0.68	1.60	8.2E-05
7440-47-3	Chromium	62000		MG/KG	120000	---	0.52	
18540-29-9	Chromium, Hexavalent	1100		MG/KG	230	0.30	4.78	3.7E-03
7440-48-4	Cobalt	45.5		MG/KG	23	420	1.98	1.1E-07
7439-89-6	Iron	100000		MG/KG	55000	---	1.82	
7439-92-1	Lead	210		MG/KG	---	---		
7439-96-5	Manganese	1035		MG/KG	1800	---	0.58	
7439-97-6	Mercury	3.1	J	MG/KG	23	---	0.13	
7440-22-4	Silver	1100	J	MG/KG	390	---	2.82	
7440-28-0	Thallium	7.4	J	MG/KG	0.78	---	9.49	
7440-31-5	Tin	26000	J	MG/KG	47000	---	0.55	
7440-62-2	Vanadium	240		MG/KG	390	---	0.62	
16887-00-6	Chloride	560	J	MG/KG	---	---		
HLA0226	Cyanide, Available	3.75		MG/KG	---	---		
57-12-5	Cyanide, Total	9.05		MG/KG	23	---	0.39	
HLA0043	Nitrogen, as Ammonia	2100		MG/KG	---	---		
14808-79-8	Sulfate	23900		MG/KG	---	---		
	EPH							
HLA0108	C11-C22 Aromatics	7500		MG/KG	10500		0.71	
HLA0109	C19-C36 Aliphatics	4900		MG/KG	305000		0.02	
	Specialty Compounds							
302-01-2	Hydrazine	0.27		MG/KG	2.0	0.032	0.14	8.4E-06
						Total	**31**	**4.1E-03**

(1) Exposure Point Concentration is maximum concentration detected in data set.
(2) Values are the Regional Screening Levels (RSLs) obtained from USEPA dated November 2019 for residential soils, HQ=1.0 or MCP S-1 values for non-cancer risks adjusted to a hazard index of 1.0.
(3) Values are the Regional Screening Levels (RSLs) obtained from USEPA dated November 2019 for residential soils based on 1E-6 risk.
RSL for 2,4,4-Trimethyl-1-pentene and 2,4,4-Trimethyl-2-pentene calculated by Olin consistent with RSL Guidance (AMEC, 2015 - OU1/OU2 HHRA Attachment 6).
RSL for Chromium (III) used for chromium.
RSL for Mercuric chloride used for mercury.
RSL for Vanadium and compounds used for vanadium.
mg/Kg - milligrams per kilogram.
C - The result is estimated due to surrogate recovery outside of control limits (GEI).
J - Value is estimated.

Table 4
Exposure Point Concentrations, Residential Human Health Hazards, and Residential Cancer Risks
Subsurface Soil (1-10 ft bgs) Human Health Risk Assessment - OU1 and OU2
Olin Chemical Superfund Site
Wilmington, Massachusetts

CAS Number	Chemical	Exposure Point Concentration (1)	(Qualifier)	Units	Non-cancer RSL HQ=1(2)	Cancer RSL (3)	Hazard Quotient/Index	Cancer Risk
	Volatile Organics							
107-39-1	2,4,4-Trimethyl-1-pentene	1200	J	MG/KG	8	---	150	
107-40-4	2,4,4-Trimethyl-2-pentene	310		MG/KG	8	---	39	
99-87-6	4-iso-Propyltoluene	5.2		MG/KG	---	---		
100-41-4	Ethyl benzene	6.7		MG/KG	3400	5.8	0.00	1.2E-06
	Semivolatile Organics							
7005-72-3	4-Chlorophenyl phenyl ether	0.17	J	MG/KG	---	---		
56-55-3	Benzo(a)anthracene	18	C	MG/KG	---	1.1		1.6E-05
50-32-8	Benzo(a)pyrene	23	C	MG/KG	18	0.11	1.28	2.1E-04
205-99-2	Benzo(b)fluoranthene	17	C	MG/KG	---	1.1		1.5E-05
207-08-9	Benzo(k)fluoranthene	21	C	MG/KG	---	11		1.9E-06
117-81-7	Bis(2-Ethylhexyl)phthalate	8600		MG/KG	1300	39	6.62	2.2E-04
86-74-8	Carbazole	0.017	J	MG/KG	---	---		
53-70-3	Dibenz(a,h)anthracene	0.15		MG/KG	---	0.11		1.4E-06
101-84-8	Diphenyl ether	3.8	J	MG/KG	34	---	0.11	
193-39-5	Indeno(1,2,3-cd)pyrene	10	C	MG/KG	---	1.1		9.1E-06
86-30-6	N-Nitrosodiphenylamine	3400		MG/KG	---	110		3.1E-05
	Pesticide/PCBs							
11096-82-5	Aroclor-1260	10		MG/KG	---	0.24		4.2E-05
	Inorganics							
7429-90-5	Aluminum	15000		MG/KG	77000	---	0.19	
7440-36-0	Antimony	41		MG/KG	31	---	1.32	
7440-38-2	Arsenic	16		MG/KG	35	0.68	0.46	2.4E-05
18540-29-9	Chromium, Hexavalent	19.9	T	MG/KG	230	0.3	0.09	6.6E-05
7440-48-4	Cobalt	14		MG/KG	23	420	0.61	3.3E-08
7439-89-6	Iron	26000		MG/KG	55000	---	0.47	
7439-96-5	Manganese	340		MG/KG	1800	---	0.19	
7439-97-6	Mercury	7		MG/KG	23	---	0.30	
7440-28-0	Thallium	0.15	JEB	MG/KG	0.78	---	0.19	
7440-62-2	Vanadium	190		MG/KG	390	---	0.49	
16887-00-6	Chloride	170	J	MG/KG	---	---		
57-12-5	Cyanide, Total	5.4	J	MG/KG	23	---	0.23	
HLA0043	Nitrogen, as Ammonia	4700	J	MG/KG	---	---		
14808-79-8	Sulfate	285000		MG/KG	---	---		
57-13-6	Urea	350		MG/KG	---	---		
	VPH							
HLA0155	C5-C8 Aliphatics	400		MG/KG	6000		0.07	
HLA0156	C9-C10 Aromatics	110		MG/KG	4550		0.02	
	EPH							
HLA0108	C11-C22 Aromatics	4700		MG/KG	10500		0.45	
	Specialty Compounds							
302-01-2	Hydrazine	1.9	Q	MG/KG	2	0.032	0.95	5.9E-05
						Total	**203**	**7.0E-04**

(1) Exposure Point Concentration is maximum concentration detected in data set.
(2) Values are the Regional Screening Levels (RSLs) obtained from USEPA dated November 2019 for residential soils, HQ=1.0 or MCP S-1 values for non-cancer risks adjusted to a hazard index of 1.0.
(3) Values are the Regional Screening Levels (RSLs) obtained from USEPA dated November 2019 for residential soils based on 1E-6 risk.
RSL for 2,4,4-Trimethyl-1-pentene and 2,4,4-Trimethyl-2-pentene calculated by Olin consistent with RSL Guidance (AMEC, 2015 - OU1/OU2 HHRA Attachment 6).
RSL for Mercuric chloride used for mercury.
RSL for Vanadium and compounds used for vanadium.
mg/Kg - milligrams per kilogram.
C - The result is estimated due to surrogate recovery outside of control limits (GEI).
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.
Q - Elevated reporting limit. The reporting limit is elevated due to high analyte levels.
T - The associated value is an estimated quantity and may be biased high due to the oxidation of Cr+3 to Cr+6.